METALOGRAM
-Mechanical Engineering and Energy-
December 15th 2024. Vol.01 No.01
Desember, 2024

ANALYSIS OF THE EFFECT OF THE SPEED OF THE CNC ROUTER SPINDLE ON THE SURFACE ROUGHNESS OF THE WORKPIECE

Robiyanto[1], Muhammad Lyan Syaputra[2], Bonggut Pakpahan[3], Wahyu Fernando[4]
Robiyanto80@gmail.com, muhammadlyan5403@gmail.com, aldipakpahan2@gmail.com, wahyufer84@gmail.com

[1,2,3,4)]*Mechanical Engineering, Universitas Riau Kepulauan, Indonesia*

*Corresponding author: muhammadlyan5403@gmail.com

Paper History

Received: December 3rd, 2024
Received in revised form: December 8th, 2024
Accepted: December 15th, 2024

ABSTRACT

In the machining process, the speed grip of the Computer Numerical Control (CNC) Router spindle on the surface area of the activity entity is very closely monitored and the physical quality of the cutting surface is also on the amount of cutting speed, thickness of the tape and the strength of the film. The aim of the study is to understand the speed grip of the CNC Router on the surface mill system on the surface of the activity entity. using spindle speeds of 1000 rpm, 1200 rpm and 1400 rpm. The equipment and materials in this study are aluminum and measuring equipment. Based on the results of the visual study, it was found that the largest and most aggressive flat body was seen at a spindle speed of 1000 rpm, and a stable flat body was seen at a spindle speed of 1200 rpm, then the smallest or strongest flat body was seen at a speed of 1400 rpm while the data from studies using Roughness Tests, it shows that the roughness average (Ra) point at a spindle speed of 1000 rpm is 0.33 µm, at a spindle speed of 1200 the Ra point is 0.30 µm, and at a spindle speed of 1400 rpm the Ra is 0.29 µm. From the results of the study, it was found that the smaller and higher the spindle rotation, the grip on the physical surface on the face mill of the experimental entity and the higher the speed of the spindle, the smoother the surface, and vice versa, the smaller the spindle rotation, the more aggressive the surface.

KEY WORDS: *CNC router, cutting surface, spindle speed, surface roughness, thickness tape*

NOMENCLATURE

Ra	Roughness
µm	micro meter
rpm	rotation per minute

1.0 INTRODUCTION

Introduction In the growth of technology on the company side, it is growing rapidly, especially in the utilization of pc systems in the machining side. In this period, PCs have been implemented into machine tools including lathes, milling machines, drilling machines and others. The result of the combination of pc technology and machinist technology is called CNC (Computer Numerical Controlled) machines. Rather, the user requirements that are dreamed of are the quality of the object of function that accuracy, noble accuracy, positive quality, completed in a short time and in large quantities, will be easier to work with CNC machines than utilizing conventional machine tools.

This CNC machine can work automatically after being programmed in advance via computer. Until now, there are half models of CNC machines ranging from 3 axis, 4 axis and 5 axis. the more axes that are found on the machine, the more charming the machining system will be and the higher the price of the machine. In the machining system, the dimensions of product quality are widely viewed from the physical, smoothness and flatness of the released plateau. physical plateau is a fundamental aspect for the quality of machining products to be obtained or not. physical quality and flatness of the cutting plateau also on the cutting condition (cutting condition), which is intended by the cutting condition is the amount of cutting readiness (cutting speed), feeding thickness (feeding) and feeding intensity (depth of cut).

To that end, the flatness as well as physical level is a critical point that should be observed in the machining system, so that the products produced have significant efficacy. For example, the physical level as well as unevenness of the noble plate on a part of a machine can result in rapid wear and tear, as a result of which the machine part is quickly deformed as well as the result is that the usefulness of the machine function will shrink. Therefore, the flatness as well as the physical plateau of the cutting results should be observed in order to obtain a noble flatness level as well as a slight physical plateau

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1.1 CNC Router

Figure 1. Machine CNC Router

CNC Router is the most commonly used type of machine and is usually used for wood, metal and plastic work. In using a cnc router, the operator does not need to manipulate the machine, only enter the program to run the machine.

1.2 Proses Face Mill

Face mill is part of indexable milling which is a straight flat cutting procedure on the axis cutter turnover. After that, the cutting process is carried out to cut both sides (the top and outside) of the edge of the milling knife.

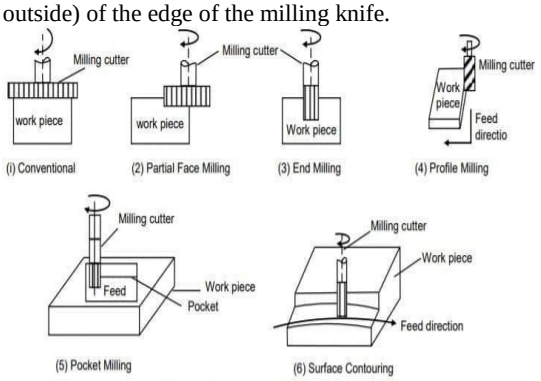

Figure 2. Proses face mill

1). Conventional Face Milling. In the conventional face milling process, the centerline of the milling cutter is wider than the workpiece as a result the milling cutter dangles on both sides of the workpiece.
2). Partial Face Milling. Partial face milling process, the milling cutter dangles on the workpiece in one of the directions.
3). End Milling. In the end milling process, the type of cutter used is smaller in diameter than the field of activity object and is used to create a slot in the activity object.
4). Profile Milling. Used for spindle rotation speed to smooth or finish face milling upright or oblique. the selected base needs to allow the endmill trajectory then penetrate is the outer edge of the part melts worked on
5). Pocket Milling. The process of milling cutters or removing pocket material in the center of the work piece.
6). Surface Milling. The process is face milling surgery for a superior base finish and is accepted as controlling the XYZ linear axis of the machine tool.

1.3 Roughness Testing Equipment

Figure 3. Roughness tester

The function of this tool is to determine the surface roughness of the test specimens that have previously been processed in accordance with the research provisions. Surface roughness is measured on a flat surface. How to measure roughness using Roughness Tester:
1). Putting the test object (in the form of aluminum according to the size that has been determined)
2). The dial indicator (in the form of a needle) is set so that the tip of the dial indicator is in a stable position on the pressure scale reading against the surface of the measurement object. Inputting factors such as the length and width of the workpiece surface to be inspected, the standard to be used (Ra and other parameters).
3). Taking data, the position of the dial indicator moves according to the horizontal axis and parallel to the workpiece (in a straight line).

1.4 Spindle Rotation Speed

The spindle speed is determined by the cutting speed. Cutting speed (Vc) is the distance traveled by the knife in meters during the cutting or cutting process in one minute.

The cutting speed formula is:

Where :
Vc = velocity (m/min)
D = knife diameter (mm)
n = spindel Speed (rpm)
л = 3.14

1.5 Deep of Feed

The depth of cut is the distance between the cut surface and the uncut surface. The depth of feed can be selected based on the workpiece material used with the cutting speed. The higher the cutting speed, the smaller the diameter of the endmill used and the finer the depth of the workpiece.

1.6 Feeding Speed

Feeding speed is the distance the endmill travels at a constant rate relative to the workpiece in millimeters per minute. The formula is:

$$Vf = n.\ fz.$$

Where:
V_f = Feeding speed (mm/min).
fz = Feeding speed (mm).

Metalogram | Received: December 3rd, 2024 | Accepted: December 15th, 2024|
Published by Program Studi Teknik Mesin, Fakalutas Teknik, Universitas Riau Kepulauan

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n= Speed rotation (rpm).
z= Number of gears on the

1.7 Surface Roughness Parameters

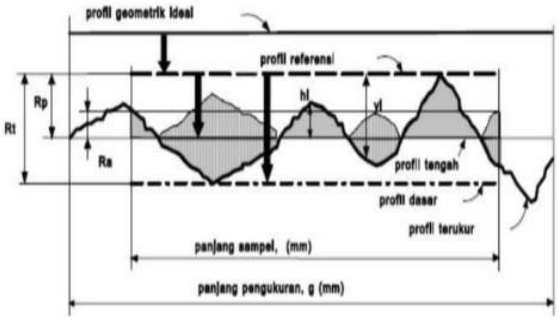


Figure 4. Surface profile

1) Total roughness Rt (µm) is the distance between the reference profile and the base profile
2) Smoothing roughness Rp (µm) is the average distance of reference profile and measured distance
3) The arithmetic mean roughness Ra (µm) is the average price of the full price of the distance between the measured profile and the center profile.
4) The quadratic mean roughness Rg (µm) is the root of the mean squared distance between the measured profile and the center profile.
5) Average total roughness Rz (µm) is the distance of the measured profile to the measured profile with the five highest peaks minus the average distance of the measured profile to the measured profile with the five lowest.

2.0 METHOD

1. Literature Study

The literature study is a preliminary research study conducted through the publication of literature regarding the CNC Router machining spindle speed research system on the surface of .5083 aluminum using a 10 mm endmill and the development of the facing process on an existing CNC milling machine. At this stage, the researcher studies and studies books related to research so as to increase insight and knowledge about the object to be researched.

2. Test Planning

Testing planning is very important to be carried out for the sake of good and maximum research results, so that the right results are obtained to carry out well-scheduled research, the planning needed is as follows: determination of the time and place of research, determination of quality characteristics and determination of parameter settings.

3. Test Preparation

Test preparation is very important for good research results, so that the resulting test results can be obtained properly, as for the preparations made are: preparation of aluminum material, preparation of facing, preparation of measuring instruments, preparation of a place on the CNC machine, preparation of the program.

4. Testing Process

This test is carried out to find out the results of the research, so that it can be said that the research is in accordance with expectations or not. At this stage, the spindle speed testing process on the CNC milling machine is carried out against the spindle speed of the CNC Router, namely: first we install aluminum on the aluminum fastener of the CNC milling machine, setting the position of the material on the CNC machine, installing the endmill on the CNC milling collet, setting the endmill on the CNC milling, machine geometry setting. Prepare the program and run the program that has been provided.

5. Data Retrieval

In collecting data, the data is taken by performing the facing process with the spindle speed that has been provided. Looking at the results of the aluminum feeding speed produced from the facing process, both the quality of the aluminum material and the results of the facing that has been used. Take notes and photos then manage or compare results from the facing process that has been carried out. The test step is carried out until the facing process is at the maximum speed that has been determined.

6. Data Analysis and Discussion

After the data from the research is obtained, the next step is to analyze the data. At the data analysis stage, the results of the data obtained will be displayed in the form of tables or pictures. After analyzing the data, the next step is to draw conclusions.

7. Conclusion and Suggestion

The last stage of the research is to conclude the results of the research which contains a brief answer to the formulation of the problem based on the data obtained. In this stage, the research also provides important suggestions to help solve existing problems and provide an overview of the use of the facing process on CNC milling machines.

3.0 RESULT

3.1 Workpiece Craftmanship Result

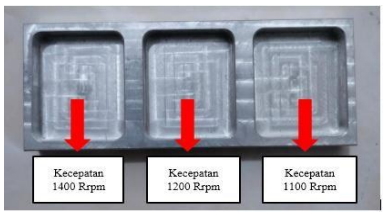
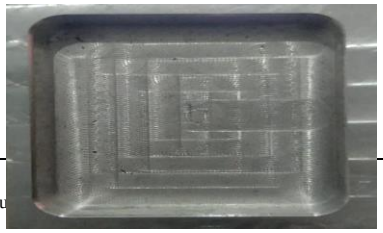


Figure 6. Aluminum with a speed of 1000 rpm. 1200 rpm, and 1400 rpm

3.2 Visual Result Data Speed 1000 rpm



Metalogram | Received: December 3rd, 2024 | Accepted: December 15th, 2024|
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Figure 7. Aluminum photo at 1000 rpm

Based on the observation of the results of the photo on the aluminum workpiece of the CNC ROUTER machining process at a spindle speed of 1000 Rpm, and a Depth of Cut of 2 mm. It can be seen in the flow drawing of the face mill process that is not visible that only the remnants and the rest look aluminum. In this illustration, there is a remnant of the face mill procedure because the speed of 1000 rpm is not so fast, so it is not able to cut the activity material quietly from the procedure Face mill, there is a section that is seen as aggressive in the channel because of the small spindle dexterity and the depth of cut that is deep, the machine in the machining procedure shakes, requiring the feeding of the material, then the impact of the material is not flat.

3.3 Visual Result Data Speed 1200 rpm

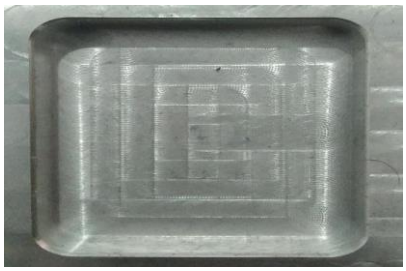

Figure 8. Photo of aluminum with a speed of 1200

Based on the observation of the results of the photo on the aluminum material resulting from the CNC ROUTER machining process with a spindle speed of 1200 Rpm, Depth Of Cut 2 mm. It can be seen in the drawing of the groove after the face mill process itself looks but it is not neat and very thick. It is also visible that there is a residue after the face mill process, but only a little because the spindle speed is also getting higher, so the knife can also cut more optimally compared to the low speed of 1000 rpm.

3.4 Data Visual Result Speed 1400 rpm

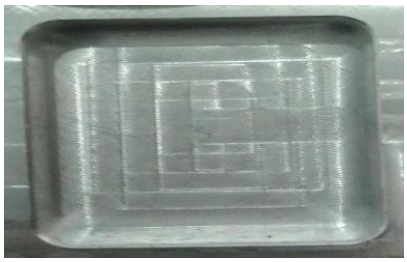

Figure 9. Photo of aluminum at 1400 rpm

Based on the observation of the results of the photo on the aluminum material resulting from the CNC ROUTER machining process with a spindle speed of 1400 Rpm, Depth Of Cut 2 mm. In the drawing of the groove after the face mill process, it is very clear that it looks straight and neat. It is also seen that the groove is neat and straight because the spindle speed is high compared to the previous two experiments so that the machine easily cuts the aluminum workpiece.

3.5 Roughness Tester Result Data Speed 1000 rpm

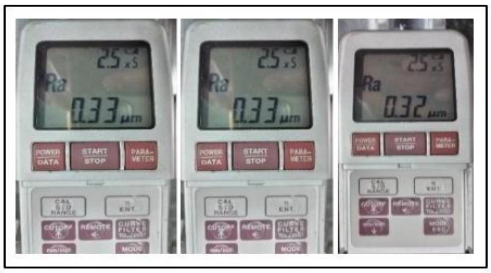

Figure 10. 1000 rpm Surface Roughness Measurement Results

Testing on specimens is carried out using a surface roughness tester at two points of each test specimen. Each point is tested along 5.37 mm of flat surface as a result of CNC milling processes. In the spindle speed test of 1000 rpm, the surface roughness value of Ra1 is 0.33 µm, Ra2 is 0.33 µm and Ra3 is 0.32 µm.

3.6 Roughness Tester Result Data Speed 1200 rpm

Figure 11. 1200 rpm Surface Roughness

In the spindle speed test of 1200 rpm, the surface roughness values of Ra1 are 0.32 µm, Ra2 is 0.32 µm and Ra3 is 0.27 µm.

3.7 Roughness Tester Result Data Speed 1400 rpm

Figure 12. 1400 rpm Surface Roughness

Measurement Results In the spindle speed test of 1400 rpm, the surface roughness value of Ra1 is 0.32 µm, Ra2 is 0.27 µm

Metalogram | Received: December 3rd, 2024 | Accepted: December 15th, 2024|
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and Ra3 is 0.27 µm.

4.0 DISCUSSION

The result of visual test we can see on the table below.

Table 1. Visual research results

No	Spindle rotation (rpm)	Visual Inspection
1	1000 rpm	In the test, the visual speed of 1000 rpm is seen in the coarse feeding groove
2	1200 rpm	In the test, it appears that the visual speed of 1200 rpm is seen in the feeding groove smoother than at the speed of 1000 rpm
3	1400 rpm	In the test, it was visually visible that the 1400 rpm speed was visible in the smoothest feeding grooves and only slightly roughness was felt in the aluminum speed of 1000 rpm and 1200 rpm

In the table 2. The roughness result.

Table 2. Roughness research results

No. Specimens	Spindle rotation (rpm)	Depth surfacing (mm)	Surface Roughness (mm)			
			T1	T2	T3	Average
1	1000	10	0.33	0.33	0.32	0.33
2	1200	10	0.32	0.32	0.27	0.3
3	1400	10	0.32	0.27	0.27	0.29

T1 = Point 1 of the workpiece to be measured.
T2 = Point 2 of the workpiece to be measured.
T3 = Point 3 of the workpiece to be measured.

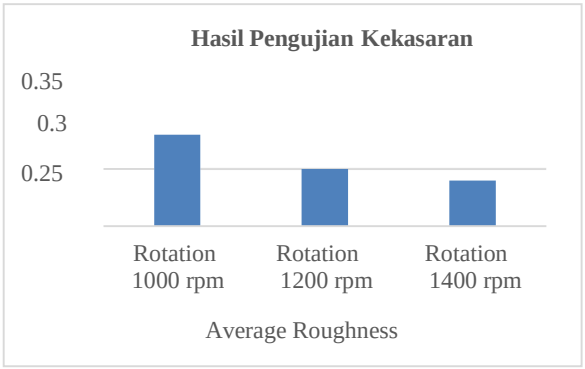

Figure 13. Roughness Test Results

The graph shows that the average Ra value at spindle speed 1000 rpm is 0.33 µm, at spindle speed 1200 the Ra value is 0.30 um, and at spindle speed 1400 rpm Ra is obtained at 0.29 Um. This can be explained if the smaller and larger the rotation of agility has a real surface on the face mill side of the functional entity, the faster the readiness of the spindle so that it is softer and flatter the plane of the working entity, as well as the opposite of the rotation of the spindle so that the surface is more aggressive.

5.0 CONCLUSION

The face mill process shows the impact of the difference in spindle tightness of 1000 rpm, 1200 rpm, and 1400 rpm on basic brutality. In the results of the image, it appears that the basic brutality is at least large aka aggressive at the 1000 rpm spindle tightness, as well as the basic brutality that is again found at the 1200 rpm spindle tightness. In the roughness testes experiment, the average Ra value at spindle speed 1000 rpm is 0.33 µm, at spindle speed 1200 the Ra figure is 0.30 µm, and at spindle speed 1400 rpm Ra is obtained at 0.29 µm. so it can be concluded that the smaller and more tight rotation has an impact on the basic brutality in terms of Face mill operating material, the tighter the spindle is getting lighter and the surface is getting lighter, as well as the opposite is getting smaller and the tightness of the surface is getting more aggressive.

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Metalogram | Received: December 3rd, 2024 | Accepted: December 15th, 2024|
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